Myocardial Sympathetic Innervation Imaging*

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RATIONALE

¹²³I-meta-iodobenzylguanidine (MIBG) (AdreView; GE HealthCare) is used to evaluate cardiac sympathetic innervation in patients with cardiac dysautonomias. MIBG is a guanethidine analog structurally similar to norepinephrine, and its myocardial uptake reflects the integrity of the cardiac postsynaptic sympathetic nervous system. In patients with New York Heart Association functional class II/III heart failure, ¹²³I-MIBG imaging can help predict 1- and 2-y mortality risk. Specifically, reduced myocardial uptake—quantified as a heart-to-mediastinum ratio of less than 1.6—in patients with a left ventricular ejection fraction of no more than 35% is associated with a higher likelihood of major cardiac events, cardiac death, and overall mortality compared with those with higher heart-to-mediastinum ratios.

CLINICAL INDICATIONS

• Assist in the evaluation of patients with New York Heart Association functional class II/III heart failure and left ventricular ejection fraction of 35% or less.

CONTRAINDICATIONS

- Pregnancy must be excluded in accordance with local institutional policy. If the patient is breastfeeding, appropriate radiation safety instructions should be provided.
- Recent nuclear medicine study (radiopharmaceutical-dependent).
- Use of a medication for noncardiac medical conditions known or suspected to interfere with ¹²³I-MIBG that cannot be withheld for at least 24 h.
- Severe renal insufficiency. Consider the impact of increased radiation exposure and poor imaging. Encourage hydration and frequent urination.
- Hypersensitivity to iobenguane or iobenguane sulfate. Investigate potential iodine allergies, including hypersensitivity to iobenguane or iobenguane sulfate.
- Neonates and infants because of benzyl alcohol, which can cause serious and fatal adverse reactions: "gasping syndrome".

PATIENT PREPARATION/EDUCATION

- The patient should not eat or drink after midnight for morning tests. Patients scheduled for an afternoon test may have a light breakfast. Patients should avoid foods with vanillin and cate-cholaminelike compounds (e.g., chocolate and blue cheese) for approximately 1 wk prior.
- Medications that interfere with uptake of catecholamines should be withheld per recommendations. These may include antidepressants, antipsychotics, and some calcium channel blockers.
- A focused history containing the following elements should be obtained:
 - Indication for the examination.
 - $\circ~$ Medications.
 - Symptoms.
 - Cardiac history.
 - Prior diagnostic or therapeutic procedures.

ACQUISITION INSTRUCTIONS

- Potassium perchlorate (~400 mg), potassium iodide, or Lugol solution (equivalent of 130 mg of iodine) may be administered 1 h before the administration of ¹²³I-MIBG for thyroid blockade (Table 1).
- The patient should lie quietly in the supine position for at least 5 min before administration of the tracer.

TABLE 1

Pharmaceutical Identity, Dose, and Route of Administration

Identity	Dose	Route of administration	Standard/ optional
Potassium perchlorate	400 mg	Oral	Optional
Potassium iodide (Lugol)	130 mg	Oral	Optional

TABLE 2

Radiopharmaceutical Identity, Dose, and Route of Administration

Identity	Dose	Route of administration
¹²³ I-MIBG (AdreView)	10 mCi (370 MBq)	Intravenous

^{*}There are no guidelines for AdreView (¹²³I-MIBG). This protocol is based on the protocol used in the ADMIRE-HF trial before AdreView was approved by the Food and Drug Administration. The protocol included in this manual may change substantially based on clinical use and published guidelines.

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TABLE 3 Acquisition Parameters: Planar/Static

Parameter	rameter Characteristic	
Camera type	Large field of view	Standard
Energy peak	159 keV	Standard
Energy window	20%	Standard
Collimator	Low-energy high resolution	Standard
Patient position	Supine	Standard
Camera position	Anterior	Standard
	Anterior and lateral (dual head)	Preferred
Injection to imaging time	Early: 15 min	Standard
	Late: 4 h	Standard
Acquisition type	Planar static	Standard
Views	Anterior	Standard
Additional views	Lateral	Optional
Orbit	NA	NA
Orbit type	NA	NA
Pixel size	6.4 mm	Standard
Matrix	128 imes 128	Standard
	256 imes256	Preferred
Number of projections	1-2 images	Standard
Time/view	10 min	Standard
Additional view time/projection	NA	NA

NA = not applicable.

- Administer 10 mCi of MIBG intravenously over 1-2 min (Table 2).
- Obtain a 10-min anterior thorax planar image 15 min after injection (Table 3). Avoid positioning the heart too close to the edge of the field of view or too close to the center.

A radioactive marker may be helpful for consistent positioning between early and late images.

- Acquire SPECT images after planar imaging (Table 4).
- Repeat planar and SPECT images at 4 h.

Acquisition Parameters: SPECT or SPECT/CT				
Parameter	Characteristic	Standard/preferred/optional		
Camera type	Large field of view	Standard		
Energy peak	159 keV	Standard		
Energy window	20%	Standard		
Collimator	Low-energy high resolution	Standard		
Patient position	Supine	Standard		
Camera position	Anterior	Standard		
Injection to imaging time	Early: 15 min	Standard		
	Late: 4 h			
Acquisition type	SPECT	Standard		
Views	NA	NA		
Additional views	NA	NA		
Orbit	180°	Standard		
Orbit type	Circular	Standard		
	Noncircular	Optional		
Pixel size	6.4 mm	Standard		
Matrix	64 imes 64	Standard		
	128 × 128	Optional		
Number of projections	Single head 60 (6°)	Standard		
	Dual head 60/head (3°)			
Time/projection	30 s	Standard		
CT Acquisition	Per manufacturer's recommendations for attenuation correction or diagnostic imaging	Optional		
NA = not applicable.				

TABLE 4

COMMON OPTIONS

- SPECT/CT or visual inspection with SPECT suggested. Resting ^{99m}Tc-tetrofosmin or ^{99m}Tc-sestamibi myocardial perfusion SPECT imaging may be performed to aid in myocardial localization.
- ¹²³I-MIBG washout may also be derived from the following formula:

Washout = ([CD heart early-CD heart late]/CD heart late) $\times 100\%$

CD represents the count densities in the heart after subtraction of the mediastinal region and after decay correction. Normal washout is approximately 42%. Increased washout suggests disruption of the cardiac sympathetic innervation complex.

PROCESSING INSTRUCTIONS

- Draw a region of interest manually around the heart to include all ventricular activity.
- Visually define the lung apices and draw a horizontal line to mark the most superior lung apex (this must be at least 2 pixels below the most inferior thyroid activity). Draw a vertical line equidistant between the right and left lungs.
- Determine the intersection of horizontal and vertical lines and examine counts for several pixels below this point. Identify the area with the lowest counts and draw a 7 × 7 × 7-pixel region of interest (128 × 128 matrix). If multiple areas demonstrate low counts, choose the most superior location.
- Determine the counts per pixel for each region of interest.
- Calculate the heart-to-mediastinal ratio.
- Process SPECT images in a manner similar to standard myocardial perfusion imaging. Filtered backprojection is most

commonly performed. The filters may need to be adjusted to obtain quality images, particularly if the counts are low.

- The images should be reconstructed into the vertical longaxis, horizontal long-axis, and short-axis views.
- Display the images with the early slices in the top row and the delayed slices below.

PRECAUTIONS

- Rapid administration of ¹²³I-MIBG can result in side effects such as palpitations, shortness of breath, heat sensation, transient hypertension, and abdominal cramps.
- There is the rare possibility of an anaphylactic reaction.

DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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